FOREST PEST MANAGEMENT
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EVALUATION OF INSECT-RELATED CONIFER MORTALITY AND RED TURPENTINE BEETLE, DENDROCTONUS VALENS (COLEOPTERA: SCOLYTIDAE), ACTIVITY FOLLOWING A PRESCRIBED BURN IN THE INDIANA SUMMIT RESEARCH NATURAL AREA, MONO LAKE DISTRICT, INYO NATIONAL FOREST

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Background

The Indiana Summit Research Natural Area (ISRNA) was established in 1932 and covers 475 hectares (1,162 acres) representing the eastside Jeffrey pine type on the Mono Lake District of the Inyo National Forest (see map). Fire is an important recurrent disturbance factor in eastside pine forests and one long-term objective for the ISRNA is to reintroduce fire as a natural ecosystem process and allow fires to burn at natural intensities with minimal human intervention. A fire-history study in the area recorded a pre-suppression fire interval from the 1800's as 15.4 years. Fire suppression for nearly a century at the ISRNA has altered ecological processes and created a forest structure, composition and successional trends that are currently considered outside ranges of natural variability. Dead and live fuels have built up significantly during the pre-1950's fire suppression period and controlled management (reduction) of fuels is necessary before wildfires can safely be allowed to burn under natural intensities and frequencies. The Inyo National Forest/ RNA Coordination Team has decided to use managed fires over the next five years to reduce fuels throughout the ISRNA to restore natural fire intervals and intensities and move toward a fire-adapted ecosystem.

To implement this strategy, a test fire phase was initiated with the objectives of determining the best season to burn, testing fire modeling ability to achieve the vegetation desired condition and determining whether controlled fire is acceptable to other resources including threatened and endangered species, wildlife, and heritage resources. The current intent is to utilize four 25 acre test plots, three ignition and one control (unburned) plot, over the next two to three years. Burns were proposed to occur one each in early May, late June and Fall (September-October), depending on burn conditions. Information from the test fires will be used to help evaluate the potential larger-scale use of fire in the ISRNA.

The initial 25 acre burn was conducted on June 6-7, 1996. In mid-August, 1996, Connie Millar, ISRNA coordinator, noticed considerable red turpentine beetle (RTB), Dendroctonus valens (Coleoptera: Scolytidae) activity in the burned area (see RTB biology). Numerous RTB attacks were observed on the lower bole of Jeffrey and lodgepole pine. The main concern was what effect RTB activity and fire impact interactions would have on desired vegetation conditions, primarily the survival of the large diameter (>/= 20 inches DBH) Jeffrey and lodgepole pine. Depending on the effects of the initial burn, implementation of the planned subsequent burns, particularly the burn scheduled for September-October, 1996, might be reconsidered. The area was visited on August 21, 1996 by Tom Higley and Dale Johnson, Mono Lake RD, Scott Kusumoto, Mammoth RD, Connie Millar, Research Geneticist, Pacific Southwest Research Station and John Wenz, Forest Pest Management (FPM) South Sierra Shared Service Area Entomologist.

Observations

The controlled burn area is a two-storied Jeffrey pine stand with a generally south/west aspect. The overstory consists of 200 to 300 year-old Jeffrey pine, 80 to 110 feet in height with diameters generally ranging between 36 and 44 inches. The second story is about 90% Jeffrey pine and 10% lodgepole pine, 80 to 120 years in age, 40 to 70 feet in height, and 12 to 20 inches DBH. The advanced regeneration is mainly Jeffrey pine with some lodgepole pine that ranges from about 40 to 80 years in age, is 20 to 30 feet in height and 4 to 10 inches DBH. Basal areas range from about 120 to 240 sq.ft./acre with denser aggregations exceeding 300 sq.ft./acre. The site is generally a Myers 70. Precipitation has been normal to above normal for the past two years but, like much of the Sierra Nevada, was preceeded by 7 to 8 years of below normal precipitation.

Eleven weeks after the burn was conducted, fire-related conifer mortality appears low to moderate and is almost entirely restricted to understory pines <12 inches DBH and mostly in the 4 inch to 8 inch range. These trees have crown scorch generally exceeding 60% of the total crown length (twig/bud survival was not evaluated) and bark scorch exceeding 50% of the total tree height. Many of these trees had woodborers (Coleoptera: Cerambycidae and Buprestidae) under the scorched areas of the bark in the lower bole. Some of the smaller diameter understory trees also had RTB attacks near the base of the tree. Although there were a few individual exceptions, bark scorch on the larger diameter trees was consistently less than 30% to 35% of tree height and less than 50% of the crown length. No Jeffrey pine beetle (D. jeffreyi) or Ips emarginatus activity was observed. One lodgepole pine appeared to have a few mountain pine beetle, D. ponderosae, attacks on the lower third of the bole.

Transects were run throughout the 25 acre burn on August 22, 1996, to determine (1) the proportion of pines 20 inches DBH and larger that were attacked by the RTB and (2) provide some estimate of the severity of attack. It is estimated that at least 75% of the pines greater than 20 inches DBH within the burn were covered by the transects. In addition, stands adjacent to the burned area were evaluated for RTB and other bark beetle activity. Results of the transects are summarized as follows:

(1) Sixty five (33%) of 197 Jeffrey pines examined were attacked by the RTB (i.e., had at least one attack indicated by a pitch tube with associated coarse red boring dust).

(2) Of the 65 Jeffrey pine attacked:

(a) 46 (71%) had fewer than 10 individual attacks. None of the pines had more than 20 total attacks.

(b) 60 (92%) had no attacks higher than 5 feet above the base of the tree. The majority of RTB attacks occurred within 3 feet of the base of the tree.

(c) 26 (40%) had 25% of the bole circumference affected by the RTB attacks, 18 (28%) had 50% of the bole circumference affected, 13 (20%) had 75% of the bole circumference affected and 8 (12%) had 100% of the bole circumference affected.

(3) No RTB attacks or other current bark beetle activity were observed in the unburned stands immediately adjacent to the burned area.

Discussion

The early June burn was conducted at a time when the coniferous vegetation was probably most susceptible to fire and insect damage. At this time, the trees are physiologically active and the terminal and lateral buds are most vulnerable to heat damage. It is also the time that the bark beetles most likely to attack fire-damaged trees are beginning adult flight dispersal and host selection. Adult beetle populations are probably at their highest between early-June and mid-August coincidental to the period when fire -damaged trees would be highly vulnerable to attack. Although these factors can vary between years and burns, the fire-insect interactions and related damage observed in the ISRNA may be an indication of a "worst case" situation.

Compared to an unburned condition, the direct effects of the fire and the consequent RTB attacks interact to increase the chances of large-diameter tree mortality in the short-term (1 to 2 years). This results from (a) direct fire injury; (b) injury from RTB attacks and (c) these factors interacting to predispose the trees to attack by other bark and engraver beetles. It may also be that the RTB functions as an indicator of significant cambium damage, not necessarily evident from the degree or extent of bark scorch, that could result in fire induced mortality the following spring.

At this point in time, the increased risk of mortality appears low. There is little indication that there will be much, if any, fire-related mortality to the large-diameter Jeffrey or lodgepole pine. No Jeffrey or mountain pine beetle activity was observed in the burned area or in the adjacent stands. The RTB commonly attacks the base of weakened, injured, or dying trees and recently cut stumps. It is not unusual to experience RTB activity on fire-scorched trees in stands that have been burned by wild or prescribed fire. The proportion of large-diameter Jeffrey pine attacked by RTB and the intensity of attacks in the 11 weeks after the burn are not exceptional. Red turpentine

beetle attacked pines frequently survive unless they are also affected by additional stress factors such as root disease (not observed in the burned area) or moisture stress. In this case, probability of mortality will be higher if trees have incurred fire induced cambium injury not indicated by the degree/extent of bark char. Below normal precipitation in the winter of 1996-97 and/or 1997-98 resulting in moisture stress would also increase chances of mortality.

Current plans for re-introducing fire to the ISRNA include conducting a second 25 acre in September-October, 1996. Given the concern and uncertainty about the fire injury/ RTB situation that has developed following the initial June, 1996 burn, the following options may be considered with respect to the proposed Fall, 1996 burn:

Option (1): Implement the Fall, 1996 burn in a 25 acre block adjacent to the block burned in June, 1996. Late-season burning reduces the likelihood of direct fire and insect-related damage. In Jeffrey pine, terminal buds become protected by scales by late-summer and are less vulnerable to heat damage. Recognizing some year to year variation, risk of immediate attack by bark beetles is reduced because adult populations are low and there should be little, if any, activity over the winter. Observations made one year after a burn conducted in the Fall of 1995, south of the ISRNA on the Mammoth District, indicate minimal bark beetle activity (Tom Higley, pers. comm.). Depending on the degree/extent of fire damage, trees will be at increased vulnerability to attack in the spring/summer of 1997 and probably 1998. Assuming that the RTB attacks in the adjacent area burned reflect increased brood survival and thus higher RTB populations, the spatial proximity to June burn area may increase chances for attack by RTB and continued population increase. Conducting the burn in the Fall of 1996 as planned may provide a better comparison with the early season June burn due to temporal continuity and will also allow fire effect/impact data to become available earlier than if the Fall burn is postponed.

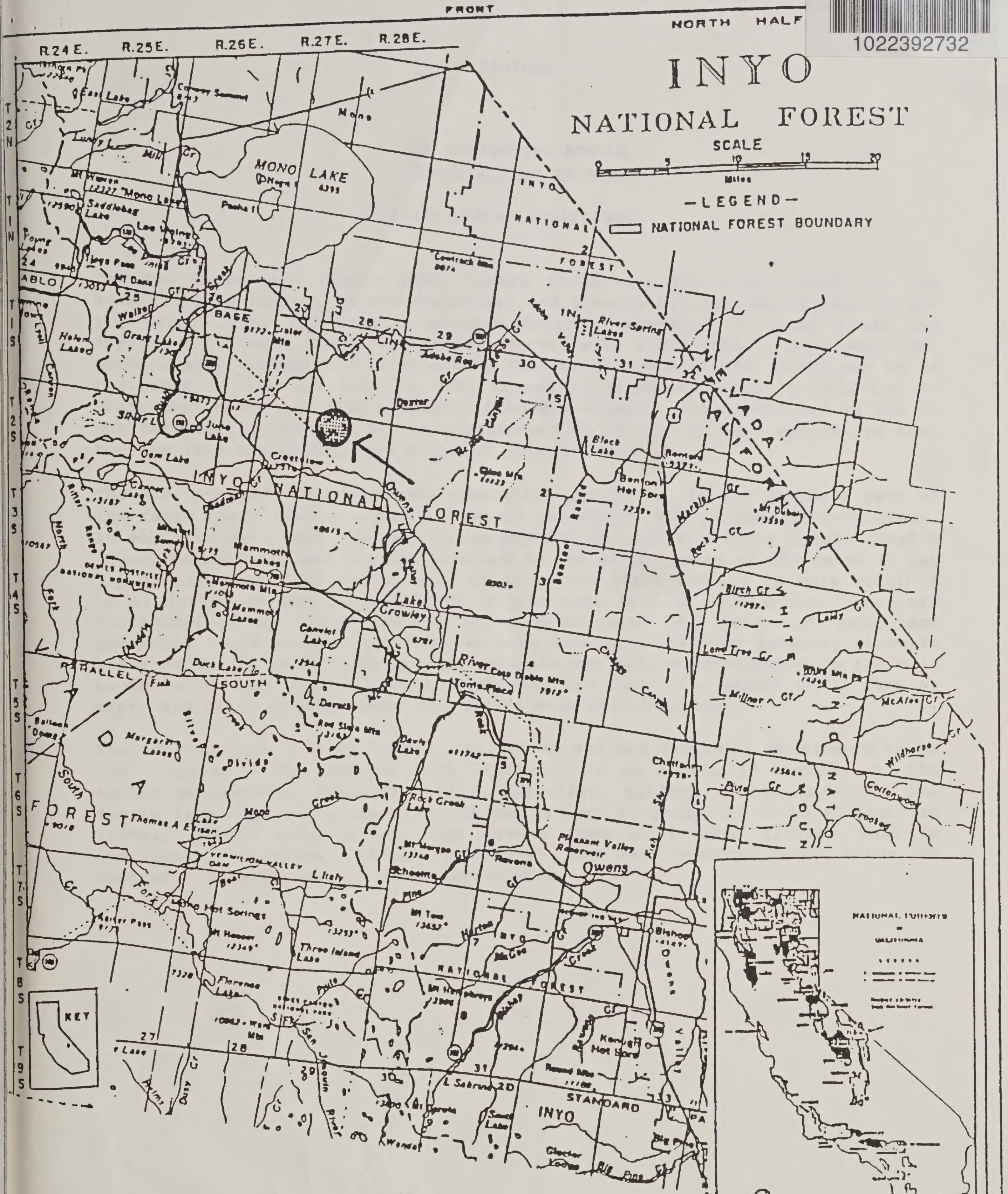
Option (2): Implement the Fall, 1996, burn in a 25 acre block separated from the block burned in June, 1996, by an unburned 25 acre block. Considerations the same as in Option (1) except that the risk of RTB attack due to spatial proximity to the June, 1996, burned plot is somewhat reduced. The degree of this risk is difficult to assess since adult bark beetles can fly several miles and RTB are no doubt present in adjacent unburned stands. To the extent that some adult RTB are still flying at the time of the Fall burn and assuming that there are more adult RTB in the vicinity of the June burn than in unburned stands near the burned blocks, providing a buffer between the areas may reduce to some extent the chance of attack in the Fall in direct response to the fire. Similarly, again assuming higher RTB populations in the June, 1996 burned plot than in nearby unburned stands, there may also be some reduced risk of attack by the 1997 beetle generation although the potential for attack by RTB migrating from nearby unburned stand would not be affected.

Option (3): Postpone implementing the Fall burn until the fire/insect effects resulting from the June, 1996 burn can be evaluated. This would allow analysis and assessment of more information from the June, 1996, burn to be utilized in deciding burn strategies for subsequent burns in the ISRNA. By late-spring/ early-summer of 1997, what first-year post-burn mortality, if any, that results from the June 1996, burn will be evident. The immediate effects

of direct fire-RTB interactions should become evident by the end of June. This would include mortality resulting from RTB activity, late-fall/ early- spring mortality due to Jeffrey and/or mountain pine beetle attack, and mortality from direct fire injury, including cambium damage. It would allow assessment of the extent to which RTB attacks might serve as indicators of cambium or tree injury/damage that ultimately results in mortality. Spring, 1997 monitoring, will also allow a much more accurate assessment of foliage-scorched but surviving (live twigs/buds) portions of Jeffrey pine crowns. By then, much of the dead foliage on live twigs will have dropped while the dead foliage on dead twigs will be retained because an abscission layer cannot be formed. By early September, 1997, the response of of the trees to the 1997 growing season can be evaluated as well as any bark or other insect-related activity. Effects on other resource attributes could be also be assessed. This option would interrupt the temporal continuity of the burns and also delay obtaining information from a Fall burn.

Potential mortality associated with Jeffrey pine beetle activity in the ISRNA was also discussed. The Jeffrey pine beetle is a native insect that has evolved along with the Jeffrey pine habitat type. Some Jeffrey pine beetle-related mortality is natural and under pre- fire suppression regimes probably occurred primarily as scattered, individual, large, slow-growing, old-growth pines and trees weakened by lightening strikes. Mortality would also likely have occurred in response to periodic droughts, naturally occurring fire injury, and to dense vegetation mosaics. However, the very large (150-200+ trees) groups of mortality and mortality pockets that increase in size over a period of 3 to 5 years or so, such has been prevalent in many drought-influenced eastside Jeffrey pine stands over the past several years, would have been relative infrequent due to the different stand conditions, fire frequencies and intensities likely present in pre-fire suppression stands.

If Jeffrey pine beetle infested pines are found within the burned plots and the mortality is considered unacceptable as a "non-natural" consequence of burning under current conditions, there is an option that is likely to be effective in preventing/ reducing subsequent Jeffrey pine beetle-related mortality in the immediate area. This involves destroying the Jeffrey pine beetle brood in infested trees before the adults emerge and attack additional trees. It can be accomplished by (1) cutting and removing infested trees from the area; (2) cutting the infested trees and peeling the bark off the infested portion of the bole; or (3) leaving the infested trees standing and peeling the bark off the infested portion of the bole.



PROJECT VICINITY MAP
INDIANA SUMMIT RNA MANAGEMENT FIRE
T.2S., R.28E., SEC. 5,6,7,8, MDM

RED TURPENTINE BEETLE
Dendroctonus valens

(Coleoptera: Scolytidae)

The red turpentine beetle (RTB) occurs throughout the pine forests in the United States (except in the southeast) and attacks all species of pine within its range. The RTB usually attacks injured, weakened or dying trees and freshly cut stumps. Ponderosa pines infected with black stain root disease are particularly susceptible to attack by RTB and evidence of RTB attack may be an indicator of the presence of root disease. Pines scorched by wildfire or prescribed burns are also susceptible to RTB attack. Trees attacked by RTB do not necessarily die but may be predisposed to attack by more aggressive bark beetles like the western and mountain pine beetles.

The RTB generally completes one generation per year. In the southern part of its range there may be a partial second generation and in the northern areas, it may take more than one year to complete a generation. Adult flight usually occurs between May and October although in the warmer parts of its range it can fly at any time. Attacks usually occur in the basal section of bole within 6 to 12 inches of the ground, often at the soil line or root crown. They are characterized by large reddish pitch tubes near the point of entry and generally found on only part of the bole circumference. On severely stressed trees or during periods of drought, attacks may extend underground on the main roots to 15 feet from the bole, extend up the bole to a height of 12 feet or more, and often affect almost the entire bole circumference.

The adults range in size from 5.3 to 8.3 mm and are generally considered to be the largest of the western bark beetles. If an attack is successful, the adults excavate an irregular, often cave-like, gallery in the cambium. The female lays eggs along the sides of the gallery in groups of 10 to 40 that are loosely packed with frass. The larvae feed in a mass (rather than in individual, discrete, larval galleries) and can destroy large areas of cambium. Both larvae and adults overwinter.